

Amended Claims

5 Claim 1: A process for preparing pyrrolealdimines, comprising the steps of:

- a) reacting 2-formylpyrrole with a primary amine,  $RNH_2$ , in an aqueous solution, wherein R is  $C_1$  to  $C_{10}$  alkyl;
- b) adding a water-immiscible organic compound to form an aqueous phase and an organic phase; and
- 10 c) isolating the organic phase.

Claim 2: The process of Claim 1 wherein R is methyl.

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15 Claim 3: The process of Claim 1 wherein the water-immiscible organic compound is selected from the group consisting of alkanes, chlorinated alkanes, cycloalkanes, and aromatic solvents.

20 Claim 4: The process of Claim 3 wherein the water-immiscible compound is selected from the group consisting of pentane, hexanes, heptanes, chloroform, dichloromethane, carbon tetrachloride, cyclopentane, cyclohexane, benzene, and toluene.

25 Claim 5: The process of Claim 1, wherein the molar ratio of 2-formylpyrrole to primary amine is between about 1:2 and about 2:1.

Claim 6: The process of Claim 1, wherein the temperature is between about 0 °C and about 100°C.

30 Claim 7: An aqueous process for preparing Cu(II) complexes of 2-pyrrole ligands comprising reacting an aqueous mixture of 2-formylpyrrole, a primary amine,  $R^1NH_2$ , and a source of Cu(II), wherein

$R^1$  is selected from the group consisting of  $C_1$ - $C_{10}$  alkyl; allyl;  $\beta$ -alanine alkyl esters;  $NHR^3$ ; and  $NR^4R^5$ ; and

35  $R^3$ ,  $R^4$ , and  $R^5$  are independently selected from the group of  $C_1$ - $C_6$  alkyl or substituted alkyl, and  $C_6$  to  $C_{12}$  aryl or substituted aryl.

Claim 8: The process of Claim 7, wherein the primary amine is selected from the group consisting of methylamine, ethylamine, propylamine,

isopropylamine, n-butylamine, t-butylamine, isobutylamine, 2-ethylhexylamine,  $\beta$ -alanine isopropyl ester, and  $\beta$ -alanine ethyl ester.

5 Claim 9: The process of Claim 7, wherein the molar ratio of 2-formylpyrrole to primary amine is from about 1:1 to about 1:10 and the molar ratio of copper to 2-formylpyrrole is from about 10:1 to about 1:10.

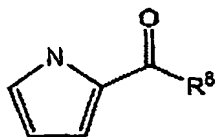
10 Claim 10: The process of Claim 7, wherein the temperature is from about 0 °C to about 100 °C.

Claim 11: The process of Claim 7, wherein the source of copper(II) is selected from the group consisting of copper hydroxide, copper(II) chloride, copper nitrate, copper sulfate, copper(II) salts of carboxylic acids, and copper alkoxides.

15 Claim 12: The process of Claim 11, wherein the source of copper(II) is copper acetate.

20 Claim 13: The process of Claim 7, wherein the reaction is conducted in the presence of a water-immiscible organic compound.

Claim 14: An aqueous process for preparing Cu(II) complexes of a 2-acylpyrrole comprising the steps of  
25 a. contacting an aqueous mixture of a source of Cu(II) with a 2-acylpyrrole,



where R<sup>8</sup> is C<sub>1</sub> to C<sub>10</sub> alkyl; and

b. further reacting the aqueous mixture with a base.

30 Claim 15: The process of Claim 14, wherein the 2-acylpyrrole is 2-acetylpyrrole.

Claim 16: The process of Claim 15, wherein the molar ratio of 2-acylpyrrole to primary amine is from about 1:1 to about 1:10 and the molar ratio of copper to 2-acylpyrrole is from about 10:1 to about 1:10.

- 5 Claim 17: The process of Claim 14, wherein the temperature is from about 0 °C to about 100 °C.

Claim 18: A Cu(II) complex comprising:

- 10 a) a copper atom; and  
b) two pyrrole ligands bound to said copper atom, wherein said pyrrole ligands are independently selected from the group consisting of 2-pyrroleald-n-propylimino, 2-pyrroleald-i-butyl-imino, 2-pyrroleald-n-butyl-imino, 2-pyrroleald-2-ethylhexyl-imino, 2-pyrroleald-m-trifluoromethylphenyl-imino, 2-pyrrolyald(2-isopropoxycarbonylethyl)imino, and 2-pyrrolyald(2-ethoxycarbonylethyl)imino ligands.
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Claim 19: A Cu(II) complex selected from the group consisting of bis(2-pyrrolyald-n-propylimino)copper(II), bis(2-pyrrolyald-n-butylimino)copper(II), bis(2-pyrrolyaldisobutylimino)copper(II), bis(2-pyrrolyald(2-ethylhexyl)imino)copper(II), bis(2-pyrrolyald(m-trifluoromethylphenyl)imino)copper(II), bis(2-pyrrolyald(2-ethoxycarbonylethyl)imino)copper(II), bis(2-pyrrolyald(2-isopropoxycarbonylethyl)imino)copper(II), and bis(2-acetylpyrrolyl)copper(II).

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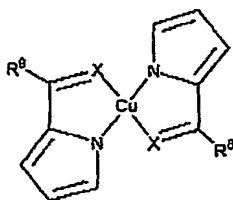
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Claim 20: A process for depositing copper on a substrate comprising:

- 30 a) adsorbing onto a substrate at least one Cu(II) complex of structure 1.

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structure 1 =



wherein:

5 X is O, and R<sup>8</sup> is C<sub>1</sub>-C<sub>10</sub> alkyl or substituted alkyl, or C<sub>6</sub> to C<sub>12</sub> aryl or substituted aryl; or

X is NR<sup>1</sup> and R<sup>8</sup> is H;

R<sup>1</sup> is selected from the group consisting of C<sub>1</sub>-C<sub>10</sub> alkyl or substituted alkyl; C<sub>6</sub> to C<sub>12</sub> aryl or substituted aryl; allyl; benzyl; NHR<sup>3</sup>; and NR<sup>4</sup>R<sup>5</sup>; and

10 R<sup>3</sup>, R<sup>4</sup>, and R<sup>5</sup> are independently selected from the group of C<sub>1</sub>-C<sub>6</sub> alkyl or substituted alkyl, and C<sub>6</sub> to C<sub>12</sub> aryl or substituted aryl; and

b) exposing said absorbed complex to a reducing agent to form copper metal.

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Claim 21: The process of Claim 22, wherein the Cu(II) complex is selected from the group consisting of bis(2-pyrrolealdmethylimino)copper(II), bis(2-pyrrolealdethylimino)copper(II), bis(2-pyrroleald-iso-propylimino)copper(II), bis(2-pyrroleald-t-butylimino)copper(II), bis(2-pyrrolealdphenylimino)-copper(II), bis(2-pyrrolyald-n-propylimino)copper(II), bis(2-pyrrolyald-n-butylimino)copper(II), bis(2-pyrrolyaldisobutylimino)copper(II), bis(2-pyrrolyald(m-trifluoromethylphenyl)imino)copper(II), bis(2-pyrrolyaldbenzylimino)copper(II), and bis(2-acetylpyrrolyl)copper(II).

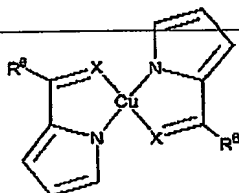
25 Claim 22: The process of Claim 21, wherein the substrate is selected from the group consisting of glass, metals and ceramics, and silicon wafers coated with a barrier layer.

30 Claim 23: The process of Claim 21, wherein the reducing agent is selected from the group consisting of ammonia, ammonia/hydrogen mixtures, hydrazine, CO/hydrogen mixtures, 9-BBN, borane,

dihydrobenzofuran, pyrazoline, diethylsilane, dimethylsilane, ethylsilane, phenylsilane, and silane.

5 Claim 24: The process of Claim 23, wherein the adsorbed copper complex is exposed to a reducing agent at a pressure of about 10 to about 760 millitorr, and the substrate is held at a temperature of about 100 °C to about 300 °C during the reduction.

10 Claim 25: A process for depositing copper on a substrate comprising heating a reducing agent and at least one Cu(II) complex of structure 1, structure 1 =



in the presence of a substrate, wherein:

15 X is O, and R<sup>8</sup> is C<sub>1</sub>-C<sub>10</sub> alkyl or substituted alkyl, or C<sub>6</sub> to C<sub>12</sub> aryl or substituted aryl; or

X is NR<sup>1</sup> and R<sup>8</sup> is H;

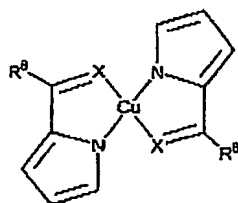
20 R<sup>1</sup> is selected from the group consisting of C<sub>1</sub>-C<sub>10</sub> alkyl or substituted alkyl; C<sub>6</sub> to C<sub>12</sub> aryl or substituted aryl; allyl; benzyl; NHR<sup>3</sup>; and NR<sup>4</sup>R<sup>5</sup>; and

R<sup>3</sup>, R<sup>4</sup>, and R<sup>5</sup> are independently selected from C<sub>1</sub>-C<sub>6</sub> alkyl or substituted alkyl, and C<sub>6</sub> to C<sub>12</sub> aryl or substituted aryl.

25 Claim 26: An article comprising a substrate with a Cu(II) complex of structure 1 adsorbed on the surface or in or on porosity in the substrate,

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structure 1 =



wherein:

5 X is O, and R<sup>8</sup> is C<sub>1</sub>-C<sub>10</sub> alkyl or substituted alkyl, or C<sub>6</sub> to C<sub>12</sub> aryl or substituted aryl; or

X is NR<sup>1</sup> and R<sup>8</sup> is H;

10 R<sup>1</sup> is selected from the group consisting of C<sub>1</sub>-C<sub>10</sub> alkyl or substituted alkyl; C<sub>6</sub> to C<sub>12</sub> aryl or substituted aryl; allyl; benzyl; NHR<sup>3</sup>; and NR<sup>4</sup>R<sup>5</sup>; and

R<sup>3</sup>, R<sup>4</sup>, and R<sup>5</sup> are independently selected from C<sub>1</sub>-C<sub>6</sub> alkyl or substituted alkyl, and C<sub>6</sub> to C<sub>12</sub> aryl or substituted aryl.

15 Claim 27: An article of Claim 26, wherein the substrate is selected from the group consisting of glass, metals and ceramics, and silicon wafers coated with a barrier layer.

Claim 28: The process of Claim 22, wherein the barrier layer is selected from the group consisting of titanium nitride and tantalum/tantalum nitride.

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Claim 29: The article of Claim 28, wherein the barrier layer is selected from the group consisting of titanium nitride and tantalum/tantalum nitride.